Casting Modeling Technology

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Modeling of the casting process has the potential to revolutionize the manner in which complex cast parts are developed. The technology allows the casting designer to predict all aspects of the casting process: molten metal flow, heat transfer, solidification, residual stresses, and the resulting microstructure within the metal casting. With such knowledge, the designer can go to the foundry with a design that preempts casting problems. The results include a shorter development time, less scrap, and higher quality castings. MSFC's Materials and Processes Laboratory is actively developing this technology to improve the quality of cast hardware for aerospace and other applications throughout the casting industry.

NASA is a member of the National Institute of Standards and Technology Consortium on Casting of Aerospace Alloys. This consortium is focused on the cooperative development of the casting modeling technology. Efforts include improving the software code and process sensors, determining fundamental thermophysical data, and validating the resulting improvements. MSFC is currently working with Howmet Corporation and United Technologies/Pratt & Whitney to support the consortium's validation task, while simultaneously improving the quality of space shuttle main engine cast hardware. This program involves modeling the casting of two main engine high-pressure oxidizer turbopump components. The first turbopump component to be modeled, the pump discharge housing, is a fairly well-understood casting, which will provide strong validation of the thermophysical data and code improvements produced by other consortium tasks. A second turbopump component, the turbine inlet housing, will provide validation data for a different material, as well as provide an opportunity to improve a casting process that has proven difficult to refine. The effort has been planned so that the results will be beneficial to all parties involved.

The Materials and Processes Laboratory is pursuing further research and development of the subject technology for application in various MSFC missions. Examples include evaluating the castability of in-house-designed cast parts, predicting the solidification behavior of castings poured in microgravity, and validating thermophysical properties determined for new, advanced alloys such as MSFC-developed NASA–23.

Casting modeling technology will provide invaluable information for future space programs and industries that rely on castings. The time and money saved by eliminating the trial-and-error casting development process will present new opportunities for cost savings and allow those programs dependent on castings to achieve their goals in a timely and cost-effective manner.

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Industry Involvement: Howmet Corporation, Whitehall, Michigan; United Technologies/Pratt & Whitney, West Palm Beach, Florida.